2025 ILEE SUMMER PROGRAM

Summer School Theme

Resilience and AI-empowered Earthquake Engineering

JULY 13 ~ JULY 26

ILEE 2025

SUMMER PROGRAM

Ying Zhou
Tongji University

Billie F. Spencer Jr
University of Illinois at Urbana-Champaign

The International Joint Research Laboratory of Earthquake Engineering (ILEE) at Tongji University was established in 2015 with the aim of serving as a platform for international collaboration and academic exchange in earthguake engineering research. After a decade of dedicated research, we are now entering a renewed phase of development, guided by the ***vision of establishing a next generation center of excellence*** for seismic engineering and its allied disciplines. This vision builds upon the progress and achievements made through collaborative efforts with our partners in earthquake engineering communities worldwide.

We would like to take this opportunity to express our sincere appreciation to the former members for their continuous contributions to the ILEE, and extend a warm welcome and heartfelt gratitude to the new members for joining us in advancing the mission of the ILEE.

As the co-directors of the ILEE, we are honored and excited to work with all of you in the coming years. Together, we believe we can make the ILEE a broader, deeper, and stronger platform.

July, 2025

The ILEE summer program is a two-week course-based program that provides state-of-the-art knowledge in Resilience and AI-Empowered Earthquake Engineering. In this program, you will take entry-level seismic resilience and AI-empowered graduate courses taught by elite seismologists and earthquake engineering researchers from around the world. By connecting with people from across the globe, you will gain a deeper understanding of seismology and earthquake engineering, master practical skills, and build a professional international network. Moreover, participants will have first-hand experience engaging with the local engineering communities, exploring Chinese culture, and witnessing fast infrastructure development. We look forward to welcoming you to Shanghai!

CONTENTS

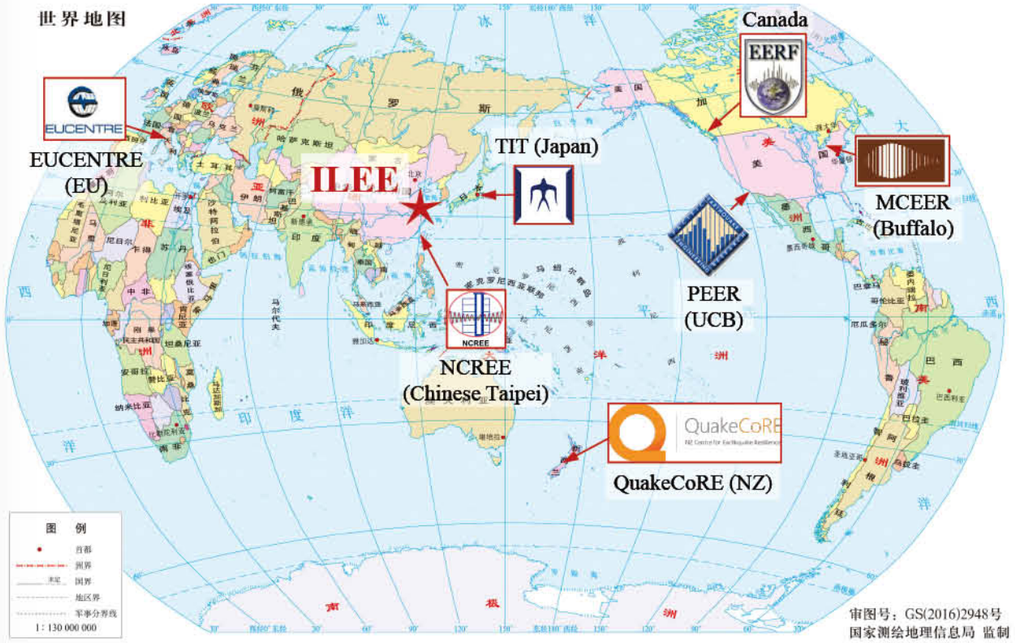
About Tongji University

Tongji University was established in 1907. It was given its present name and became a state university in 1927. It was one of the oldest and most prestigious institutions of higher education in China. The university has developed rapidly in all respects over the past decades since the founding of China, especially since the country's opening-up policy. It is now a comprehensive university with ten major disciplines in sciences, engineering, medicine, humanities, law, economics, management, philosophy, arts and pedagogy with strength in architecture, civil engineering and oceanography.

Tongji University has been one of the most popular universities in the country, attracting a large number of students from all parts of China and all over the world. In particular, it has become the number one choice of those who are pursuing a career in the field of architecture and civil engineering.

The university has developed close links with industry, which provides its students with opportunities of obtaining first-hand information through interaction with the society. That explains why graduates from Tongji University are much sought after by employers throughout the country.

About ILEE



10 year cooperation agreements with seven international earthquake engineering centers

The International Joint Research Laboratory of Earthquake Engineering (ILEE) is an internationally acclaimed center of excellence jointly administered by the Ministry of Education (MOE) and the Ministry of Science and Technology (MOST) in China. It was established in 2015. The headquarter of ILEE is located at Tongji University in Shanghai, China.

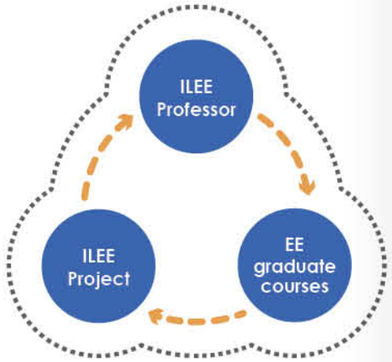
ILEE's primary objective is to provide a robust platform for renowned international earthquake engineering researchers to exchange ideas, collaborate on research projects, utilize shared facilities, and facilitate the exchange of scholars, researchers, staff, and students. The laboratory also facilitates the exchange of laboratory test data among its members.

Currently, ILEE stands as the largest earthquake engineering research network globally. Its core members include the Pacific Earthquake Engineering Research Center (PEER) in the United States, the Urban Disaster Prevention Research Core (UDPRC) at the Tokyo Institute of Technology in Japan, the European Centre for Training and Research in Earthquake Engineering (EUCenter) in Italy, the Multidisciplinary Center for Earthquake Engineering Research (MCEER) in the United States, the Earthquake Engineering Research Facility (EERF) in Canada, the NZ Center for Earthquake Resilience (QuakeCoRE) in New Zealand, and the National Center for Research on Earthquake Engineering (NCREE) in Chinese Taipei.

ILEE's primary focus is to conduct advanced collaborative research on an international scale, aiming to develop innovative solutions to mitigate seismic vulnerability worldwide and pave the way for next-generation earthquake engineering solutions.

Reasons to join ILEE Summer Program

- Equip yourself with the state-of-the-art knowledge in earthquake engineering by taking entry-level graduate courses from the world renowned earthquake engineering researchers.
- Take part in cutting edge earthquake research in some of the largest and most advanced laboratories worldwide.
- Be part of the fast-growing global network of elite earthquake engineering community.
- Experience China, a fascinating country with a rich history, infrastructures, culture, art and amazing food!



ILEE Summer Program

We are offering the following courses:

- Advanced Seismic Engineering of Foundation-Structure Systems and Underground Facilities
- Next-generation Smart, Carbon-Neutral and Resilient Infrastructure and Construction
- Introduction to Causal Machine Learning with Earthquake Engineering Applications
- Innovative Materials to Improve Seismic Resilience of Bridges and Structures
- Self-Centering Systems for Resilient Seismic Design
- Characterizing Hazards and Impacts of Induced Seismicity
- Methods for Assessing and Improving Seismic Resilience of Buildings

The following practical activities will also be provided:

- Course Practice:

Visiting the laboratory at the main campus;

Visiting the Earthquake Engineering Laboratory at the Jiading campus;

Visiting the large Civil Engineering Companies

- Site Visit:

Visiting the International Civil Engineering Companies and Major Construction Projects in Shanghai;

Visiting the Shanghai Zhangjiang High tech Park and the Shanghai Research Institute for Intelligent Autonomous Systems

- City Tour: Bund tourist tunnel, Yu Garden and Shanghai Xintiandi

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Advanced Seismic Engineering of Foundation-Structure Systems and Underground Facilities

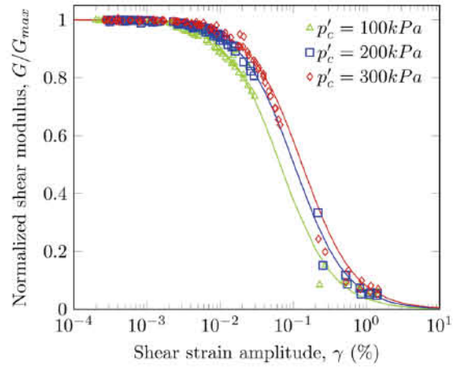
Daniel Dias

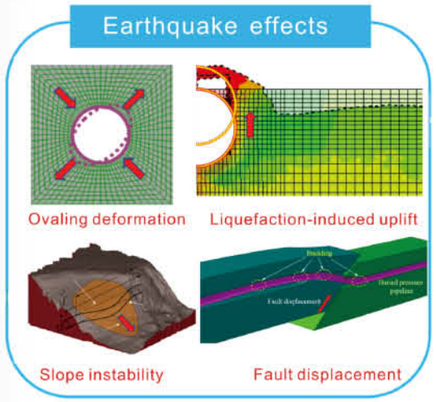
Professor, Laboratory 3SR
University of Grenoble Alpes, France

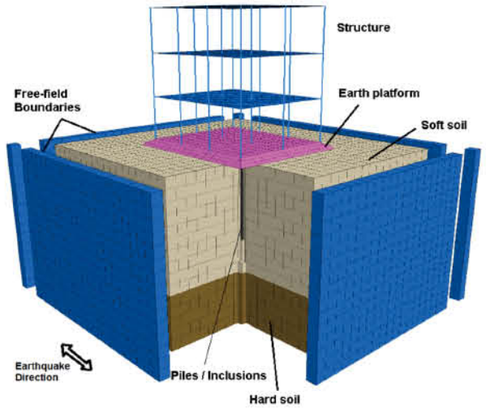
This course will provide an introduction to geotechnical earthquake engineering, with a focus on the seismic resilience of foundation-structure systems and underground facilities.

It will begin with the fundamentals of soil dynamics, dynamic loading, basic vibration theory, dynamic properties of soils, wave propagation in soils, ground response analysis, soil-structure interaction, and soil liquefaction.

In the second part of the course, attention will shift to recent developments in the seismic resilience of foundation-structure systems and underground infrastructures.







Next-generation Smart, Carbon-Neutral and Resilient Infrastructure and Construction

Tony T.Y. Yang

Professor, Department of Civil Engineering
Director, Smart Structures Laboratory
University of British Columbia, Canada

Civil infrastructure is facing significant demands from rapid population growth, aging and natural disasters. The next-generation civil infrastructure needs to be smart, carbon-neutral and resilient. This presentation presents the state-of-the-art technologies in high-performance, carbon neutral, earthquake resilient structural systems, and AI inspections and robotic construction.

Introduction to Causal Machine Learning with Earthquake Engineering Applications

Henry V. Burton

Presidential Chair and Associate Professor, Department of Civil and Environmental Engineering
University of California, Los Angeles, USA

Collecting and analyzing empirical data are essential to learning and implementing lessons in earthquake engineering. This course will introduce students to the fundamentals of causal inference and demonstrate how these principles and models can be applied to earthquake engineering problems. Specific applications of causal machine learning that will be discussed include (i) quantifying the benefit of seismic interventions using reconnaissance data, (ii) evaluating the effectiveness of ground motion intensity measures and (iii) extracting causal information from data generated by disparate structural experiments.

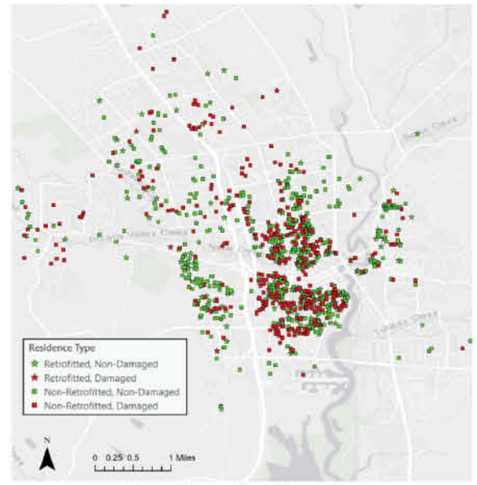


Figure 1 Types of data-driven studies

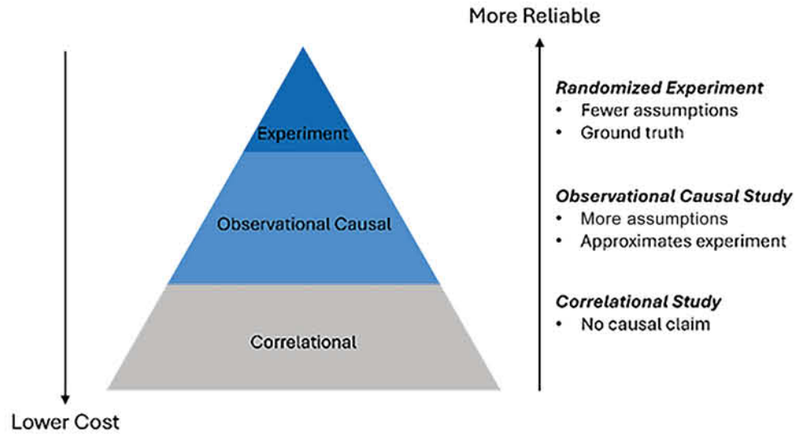


Figure 2 Observational damage data from the 2014 M 6.0 South Napa earthquake

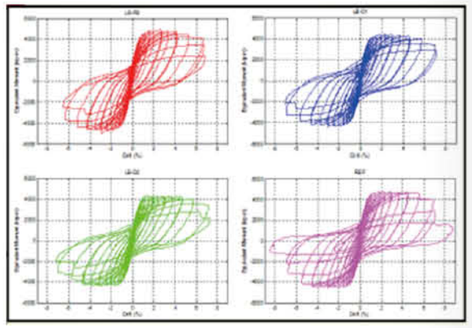
Innovative Materials to Improve Seismic Resilience of Bridges and Structures

Bijan Khaleghi

Chair, International Association of Bridge and Earthquake Engineering (IABEE)
Associate Professor and Co-Director, Florida International University, USA
Adjunct Professor, Saint Martin's University, USA

This course provides a comprehensive review of seismic current design requirements for infrastructures, to bridge the gap between theoretical research and field applications by providing sufficient insight into the physical principles, and implementation projects.

This course covers state-of-the-art seismic topics including: 1-Improving seismic resiliency with super-elastic materials in bridge bents, 2-Seismic resiliency and post-earthquake functionality of bridge with self-centering capability, 3-Tsunami resiliency of bridges, 4- Seismic retrofit and strengthening of bridges with ultra high-performance concrete (UHPC), 5-Concrete filled steel tubes (CFST) for bridge projects with enhanced seismic performance, and 6-Seismic resiliency of bridges, tunnels, and underground structures.

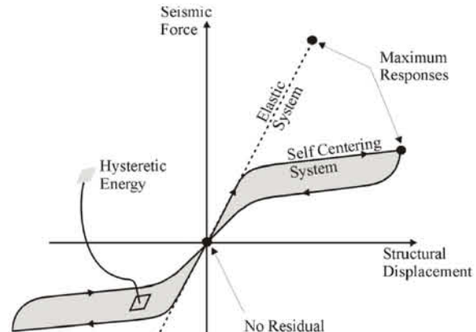


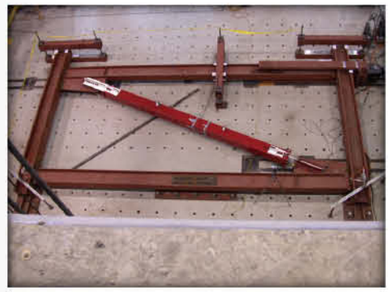
Self-Centering Systems for Resilient Seismic Design

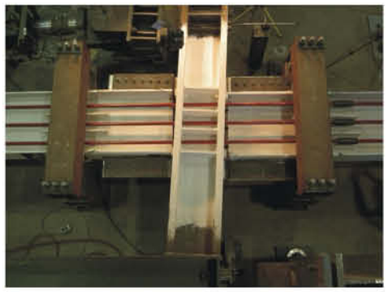
Constantin Christopoulos

Professor and Director, Department of Civil and Mineral Engineering
Director, Structural Testing Facilities
University of Toronto, Canada

This lecture series first provides an overview of the expected seismic performance of current structural systems with an emphasis on the damage state that is expected severe earthquakes. The development, validation and implementation of new systems, including self-centering energy dissipative frames and bracing systems, controlled rocking systems and rocking podium systems will then be presented. An overview of the nonlinear dynamics of self-centering systems will be discussed with an emphasis on how to engineer these systems for stable and predictable response. Results from large-scale experiments and numerical studies the highlights their improved seismic performance will be presented. Finally, some insights on design methods and strategies for implementation and codification of these systems will also be discussed.





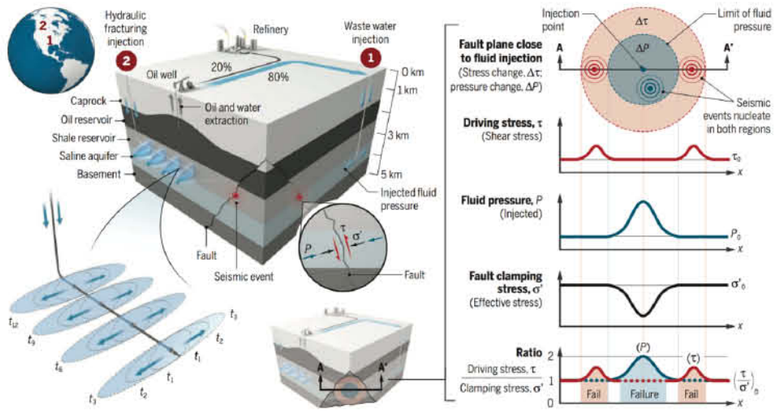


Characterizing Hazards and Impacts of Induced Seismicity

Derek Elsworth

G. Albert Shoemaker Chair and Professor, Department of Energy and Mineral Engineering
Pennsylvania State University, USA

Contemporary methods of energy conversion that reduce carbon intensity and address the energy transition draw heavily on fluids and minerals in the subsurface. This includes sequestering CO2, fuel switching to lower-carbon sources, recovering deep geothermal energy via EGS, and diurnal and inter-seasonal storage of heat, H2 and energized fluids (CAES) together with conventional resources and underground construction. We explore the mechanics of induced seismicity related to fluid injection as related to unconventional energy resources and the spectrum of seismicity in mines and tunneling and in hazardous gas outbursts. We explore the use of machine learning to provide insights into key process controls, inform physically-based models and use these to understand the hazard and mitigate risks.

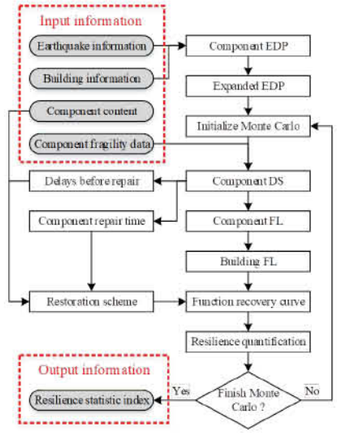


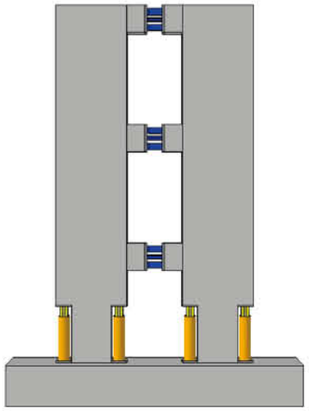
Methods for Assessing and Improving Seismic Resilience of Buildings

Huanjun Jiang

Professor, College of Civil Enigeering, Tongji University

This lecture addresses methods for evaluating and enhancing building seismic resilience. First, conventional assessment frameworks from guidelines are summarized, which rate seismic resilience based on post-earthquake casualties, restoration cost, and downtime. Then, a new method based on quantification of time-varying building function is proposed, integrating consequence analysis of components, logic trees connected with fuzzy operators, and logic system of buildings including relevance between stories to address uncertainty in evaluations. Also, the repair scheme is considered in computation of the time-varying function loss during the whole recovery process. The proposed method is embedded in probabilistic performance-based earthquake engineering (PBEE), in which uncertainty factors during the whole life cycle of buildings can be considered. Case study is provided to demonstrate the applicability of the proposed method. Finally, strategies for improving resilience of buildings are discussed, focusing on three types of earthquake resilient structures, i.e. rocking structures, self-centering structures, and the structures with replaceable components.





Multi-functional Shaking Tables Laboratory

Overview

The "Multi-functional Shaking Tables Lab" is a prominent testing division within SLDRCE. The lab has contributed scientific and technological services to numerous major and complex projects, as well as international collaborative research projects, such as the "HK-Zhuhai-Macao Bridge and Tunnel" and the "Chongqing Raffles City Building." The lab has played a pivotal role in driving industrial advancements, boosting innovation capabilities, and advancing seismic technologies for structures and infrastructure.

Testing Facilities

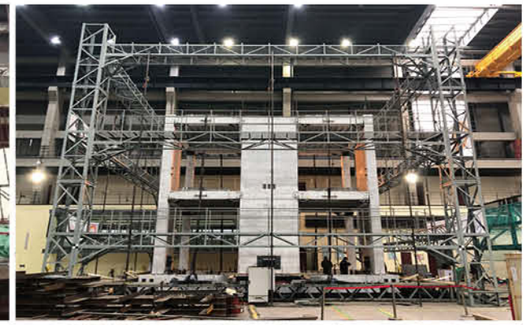
The multi-functional shaking tables testing system is composed of four shaking tables: A (30-ton side table), B (70-ton main table), C (70-ton main table) and D (30-ton side table). It also includes two trenches (70m and 30m in length, respectively) and one reaction wall. The system has three working modes: linear shaking tables array mode, rectangular shaking tables array mode and combined table mode.

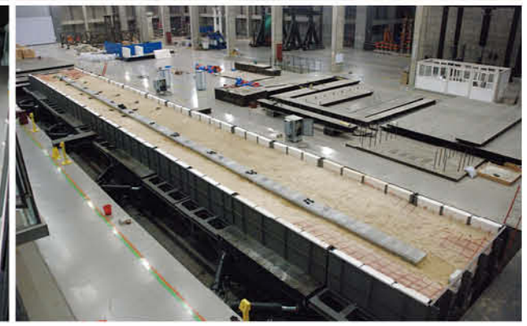
Item	Table A and D	Table B and C
Table size	6m×4m	
Specimen Mass at maximum acceleration	30ton	70ton
Degree of freedom in control	3 dof (longitudinal, lateral, yaw)	
Stroke	±500mm (X axis、Y axis)	
Velocity	±1000mm/s (X axis、Y axis)	
Acceleration	±1.5g (X axis、Y axis)	
Frequency of operation	0.1 ～ 50Hz	
Overturning Moment	200ton · m	400ton · m

Research Area

With a total testing capacity of 200 tons, the system is among the largest and most capable multiple shaking tables systems in the world. The multi-functional shaking tables testing system provides a world-leading vibration and earthquake simulation platform for bridge engineering, building engineering, spatial structural engineering, underground structure engineering and lifeline engineering.

Major Cases





1 2
3 4

1. Chongqing Raffles City Building
2. Low Damage Concrete Building (China-New Zealand International Cooperation Project)
3. Taizhou Yangtze River Bridge
4. HK-Zhuhai-Macao Bridge and Tunnel

Visiting Major Construction Projects in Shanghai

Tongji Architectural Design (TJAD)

Tongji Architectural Design (Group) Co., Ltd. (TJAD), formerly known as the Architectural Design and Research Institute of Tongji University, was founded in 1958 and has now developed into a well-known large-scale design & consulting group. With the profound cultural foundation of Tongji University, TJAD has accumulated rich experience in both engineering design and technical consultancy. It has employed more than five thousand outstanding architectural design and engineering personnel. TJAD has dealt with thousands of project cases in China, Africa and South America and ranked 61st in the “TOP 150 GLOBAL DESIGN FIRMS” published by ENR.

East China Architectural Design & Research Institute Co., Ltd. (ECADI)

East China Architectural Design & Research Institute Co., Ltd. (ECADI) is a diversified Chinese engineering business company headquartered in Shanghai that provides design, engineering, architecture, planning, and advisory services across every aspect of the built environment affiliated to Arcplus Group. ECADI, established on 19 May 1952, was one of the first largest building advisory companies in the People's Republic of China and the limited company was incorporated in 1999.

ECADI upholds the entrepreneurship of 'Efficient, Cooperative, Advanced, Dedicated, Innovated' to follow national development strategies. ECADI strives to become an international design company taking a lead in China and boasting international competitiveness. ECADI is dedicated to providing integrated territorial development services of innovative design and advisory for high-quality urban development.

ECADI has completed a large number of major projects of various types in key regions and cities throughout the country, such as the Oriental Pearl TV Tower, Shanghai Hongqiao Comprehensive Transportation hub, the Mercedes-Benz ArenaCCTV New Headquarters, National Exhibition and Convention Center (Shanghai), etc. ECADI has won thousands of international, national, Ministry of Construction and other awards, and has edited and participated in a large number of national and local industry engineering construction standards, norms and regulations.

With the philosophy and brand image of 'a beautiful life with innovative Chinese design', ECADI strives to create a better urban life for citizens with the pioneering innovative design in urban construction in the new century.

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Visiting Major Construction Projects in Shanghai

Shanghai Urban Construction Tunneling Equipment Co., Ltd

Shanghai Urban Construction Tunneling Equipment Co., Ltd. (formerly "Shanghai Tunnel Engineering Co., Ltd., Machinery Manufacturing Branch") is affiliated with Shanghai Tunnel Company’ s wholly owned enterprises. Also called the "domestic shield industry base," it was founded in 1965. It specializes in the design and manufacture of full-section tunnel boring machines, reinforced concrete lining steel, pipes, and other underground construction machinery. The company provides whole life cycle management, remanufacturing equipment, and comprehensive solutions related to tunnel engineering equipment as a high-tech enterprise.

The Green Science and Technology Demonstration Building of Yangtze River Delta Integration

The Green Science and Technology Demonstration Building of Yangtze River Delta Integration represents the implementation path for Shanghai Construction Group to actively explore carbon-neutral buildings. This project integrates the green concept throughout the entire life cycle, including design, construction, operation, and maintenance. It emphasizes planning first, design leadership, and innovation driving the process. The building has achieved the 3-star Label for Green Building and Healthy Building in China, LEED Platinum and WELL Platinum certifications in the US, and BREEAM Outstanding rating in the UK.

Visiting Shanghai Zhangjiang High tech Park and the Shanghai Research Institute for Intelligent Autonomous Systems

Introduction of Shanghai Research Institute for Intelligent Autonomous Systems

On December 17, 2018, Shanghai Research Institute for Intelligent Autonomous Systems, established based on Tongji University, was unveiled in Shanghai.

Shanghai Research Institute for Intelligent Autonomous Systems follows the laws of scientific development, guided by a holistic and systematic approach. The center focuses on the scientific development and major needs of autonomous intelligent unmanned systems, with the main tasks of scientific discovery, knowledge creation, and technology invention in the field of artificial intelligence. It attracts high-end talents from home and abroad, establishes scientific basic research facilities, and emphasizes the development of key research platforms.

Shanghai Research Institute for Intelligent Autonomous Systems focuses on three key scientific issues: autonomy and perception, intelligence and emergence, and collaboration and collective intelligence. It conducts research and tackles challenges in nine research directions: metamaterial perception, multi-scale fusion, nature-inspired computation, autonomous intelligent agents, integration of biological-electronics, autonomy and interaction, heterogeneity and decision-making, multi-body and collaboration, and neuromorphic and bionic systems. It aims to build a national major scientific and technological infrastructure for unmanned system multi-body collaboration, a research center for next-generation devices and algorithms, a center for autonomous intelligent systems and multi-body integration in land, sea, air, and space, and a platform for unmanned system application research, development, and transformation. The center strives to break through core technologies such as intelligent sensing, intelligent control, unmanned terminals, and network coordination and control systems, aiming to achieve a number of original and innovative research achievements in the field of autonomous intelligent unmanned systems, and actively promote industrial transformation in areas such as smart cities, intelligent construction, intelligent manufacturing, intelligent healthcare, and intelligent transportation.

Schedule

Date	Program	Location
13 Jul.	14:00 – 18:00 Registration	Room B504, Civil Engineering Building
14 Jul.	**Opening Ceremony** 08:30 – 08:50 Welcome speech **Wen Yin**, Director, Foreign Affairs Office, Tongji University **Xilin Lu**, CAE member, Chair of Scientific Committee of ILEE **Ying Zhou**, Dean, College of Civil Engineering, Tongji University Director, ILEE, Tongji University 08:50 – 09:00 Group photo Lecture: **Advanced Seismic Engineering of Foundation-Structure Systems and Underground Facilities** Professor: **Daniel Dias** 09:00 – 10:00 Lecture 10:00 – 10:30 Break 10:30 – 11:30 Lecture 11:30 – 14:00 Lunch break 14:00 – 15:00 Lecture 15:00 – 15:30 Break 15:30 – 16:30 Lecture	Room B504, Civil Engineering Building
15 Jul.	City Tour 09:00 – 20:00 **Bund Tourist Tunnel, Yu Garden and Shanghai Xintiandi**	Meet at Tongji University gate (200 Chifeng Road)
16 Jul.	Lecture: **Methods for Assessing and Improving Seismic Resilience of Buildings** Professor: **Huanjun Jiang** 09:00 – 10:00 Lecture 10:00 – 10:30 Break 10:30 – 11:30 Lecture 11:30 – 14:00 Lunch break 14:00 – 15:00 Lecture 15:00 – 15:30 Break 15:30 – 16:30 Lecture	Room B504, Civil Engineering Building
17 Jul.	Course Practice 09:00 – 16:00 **Visiting the laboratory at the main campus;** **Visiting the Earthquake Engineering Laboratory at the Jiading campus**	Meet at Tongji University gate (200 Chifeng Road)
18 Jul.	Lecture: **Next-generation Smart, Carbon-Neutral and Resilient Infrastructure and Construction** Professor: **Tony T.Y. Yang** 09:00 – 10:00 Lecture 10:00 – 10:30 Break 10:30 – 11:30 Lecture 11:30 – 14:00 Lunch break 14:00 – 15:00 Lecture 15:00 – 15:30 Break 15:30 – 16:30 Lecture	Room B504, Civil Engineering Building

Date	Program	Location
19 Jul.	Site Visit 09:30 – 16:00 **Visiting the International Civil Engineering Companies**	Meet at Tongji University gate (200 Chifeng Road)
20 Jul.	Lecture: **Innovative Materials to Improve Seismic Resilience of Bridges and Structures** Professor: **Bijan Khaleghi** 09:00 – 10:00 Lecture 10:00 – 10:30 Break 10:30 – 11:30 Lecture 11:30 – 14:00 Lunch break 14:00 – 15:00 Lecture 15:00 – 15:30 Break 15:30 – 16:30 Lecture	Room B504, Civil Engineering Building
21 Jul.	Site Visit 09:30 – 16:00 **Visiting the Major Construction Projects in Shanghai**	Meet at Tongji University gate (200 Chifeng Road)
22 Jul.	Lecture: **Characterizing Hazards and Impacts of Induced Seismicity** Professor: **Derek Elsworth** 09:00 – 10:00 Lecture 10:00 – 10:30 Break 10:30 – 11:30 Lecture 11:30 – 14:00 Lunch break 14:00 – 15:00 Lecture 15:00 – 15:30 Break 15:30 – 16:30 Lecture	Room B504, Civil Engineering Building
23 Jul.	**Academic Exchange and Assessment** 09:00 – 11:30 Presentation by each student (10 minutes including 3 minutes Q&A) 11:30 – 14:00 Lunch break 14:00 – 16:30 Presentation by each student (10 minutes including 3 minutes Q&A)	Room B504, Civil Engineering Building
24 Jul.	Lecture: **Introduction to Causal Machine Learning with Earthquake Engineering Applications** Professor: **Henry Burton** 09:00 – 10:00 Lecture 10:00 – 10:30 Break 10:30 – 11:30 Lecture 11:30 – 14:00 Lunch break 14:00 – 15:00 Lecture 15:00 – 15:30 Break 15:30 – 16:30 Lecture	Room B504, Civil Engineering Building

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Date	Program	Location
25 Jul.	Lecture: **Self-Centering Systems for Resilient Seismic Design** Professor: **Constantin Christopoulos** 09:00 – 10:00 Lecture 10:00 – 10:30 Break 10:30 – 11:30 Lecture 11:30 – 14:00 Lunch break 14:00 – 15:00 Lecture 15:00 – 15:30 Break 15:30 – 16:30 Lecture	Room B504, Civil Engineering Building
26 Jul.	**Closing Ceremony** **Ying Zhou**, Dean, College of Civil Engineering, Tongji University Director, ILEE, Tongji University **Haitao Yu**, Vice Diretor, ILEE, Tongji University **Wei Wang**, Vice Diretor, ILEE, Tongji University **Yan Xu**, Vice Diretor, ILEE, Tongji University **Yiqiu Lu**, Vice Diretor, ILEE, Tongji University 09:00 – 11:00 Closing Ceremony and Certificate Award	Room B504, Civil Engineering Building

Directions

Tongji University *1239 Siping Road, Yangpu District, Shanghai*

1.Hongqiao Airport / Hongqiao Railway Station: *Take Metro Line 10 directly to Tongji University Station (about 1 hour)*

2.Pudong International Airport: *Take Metro Line 2 to East Nanjing Road Station, then transfer to Metro Line 10 (towards Jilong Road) to Tongji University Station (about 90 minutes)*

3.Access to the campus: *Please bring a valid ID card or passport.*

Registration Location: ***Classroom B504, College of Civil Engineering, Tongji University***

Accommodation: ***Tongji University Expert Service Center*** *(No. 69, Zhangwu Road, Yangpu District, Shanghai)*

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